

PNEUMONIA

TUCOM

Dep. of Medicine

4th year

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PNEUMONIA

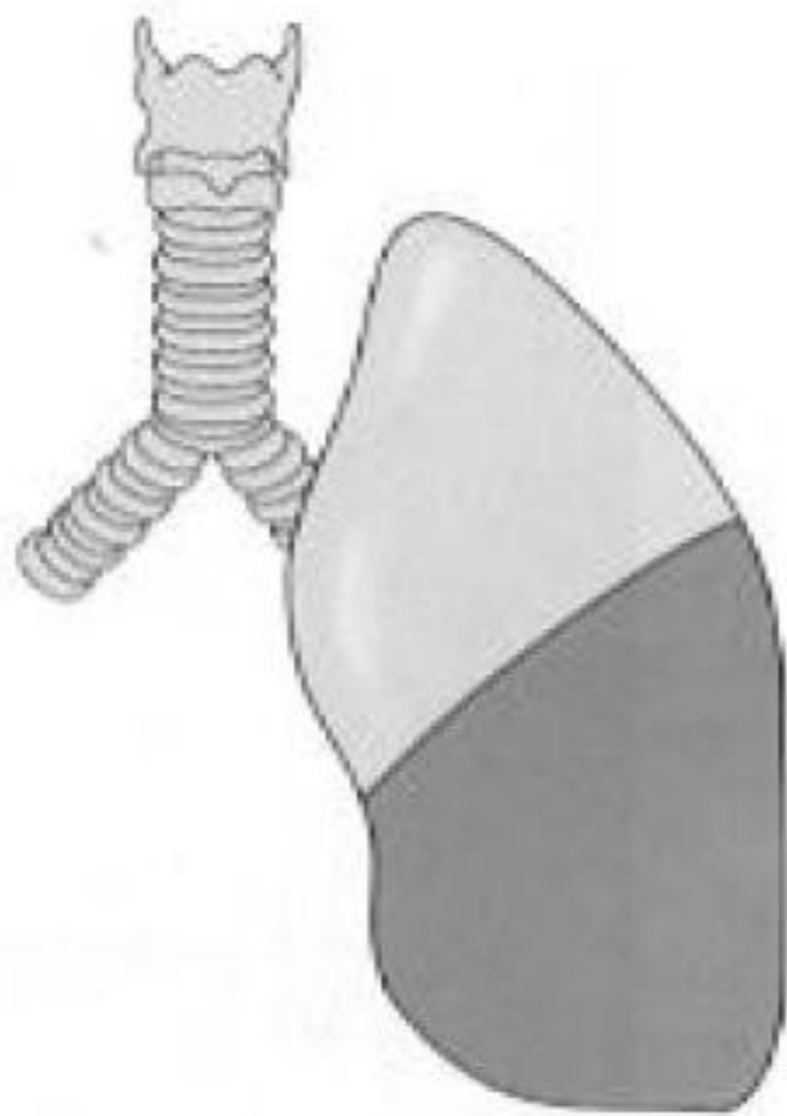
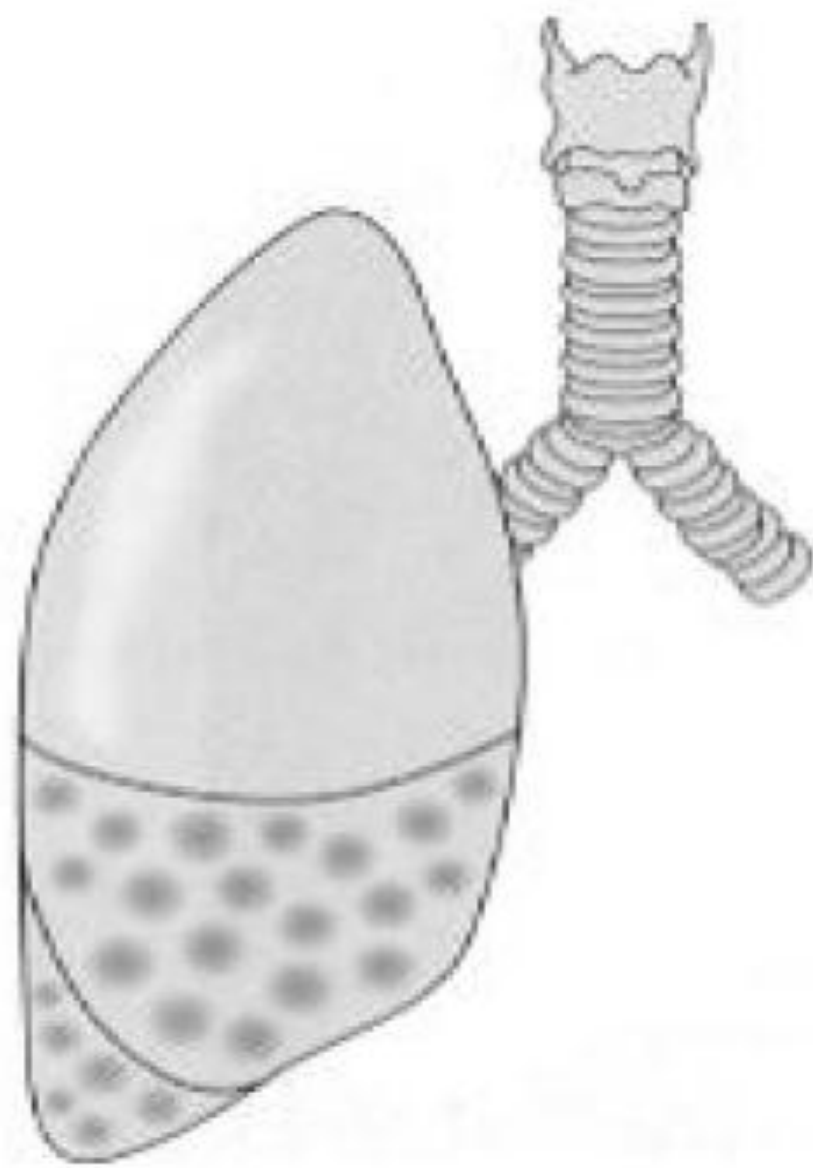
1. Define pneumonia
2. Classify pneumonia
3. Review the pathology of lobar pneumonia
4. Clarify the common forms and organisms that cause community acquired pneumonia
5. Outline the investigations of pneumonia
6. Review the treatment of pneumonia
7. List the complications of pneumonia
8. Write short notes about hospital-acquired pneumonia, aspiration pneumonia and pneumonia in the immunocompromised patient

PNEUMONIA

- Pneumonia is an acute infection of the lung parenchyma.
- **CLASSIFICATION:**
 - 1- Aetiology
 - 2- Morphology: Bronchopneumonia vs. lobar pneumonia (which may be segmental, lobar or multilobar)

Lobar pneumonia: is a radiological and pathological term referring to homogeneous consolidation of one or more lung lobes, often associated pleural inflammation

Bronchopneumonia: refers to more patchy alveolar consolidation associated with bronchial and bronchiolar inflammation often affecting both lower lobes
 - 3- Community acquired vs hospital acquired (nosocomial) pneumonia.
 - 4- The patient's immune status.



Bronchopneumonia

Lobar pneumonia



Lobar Pneumonia

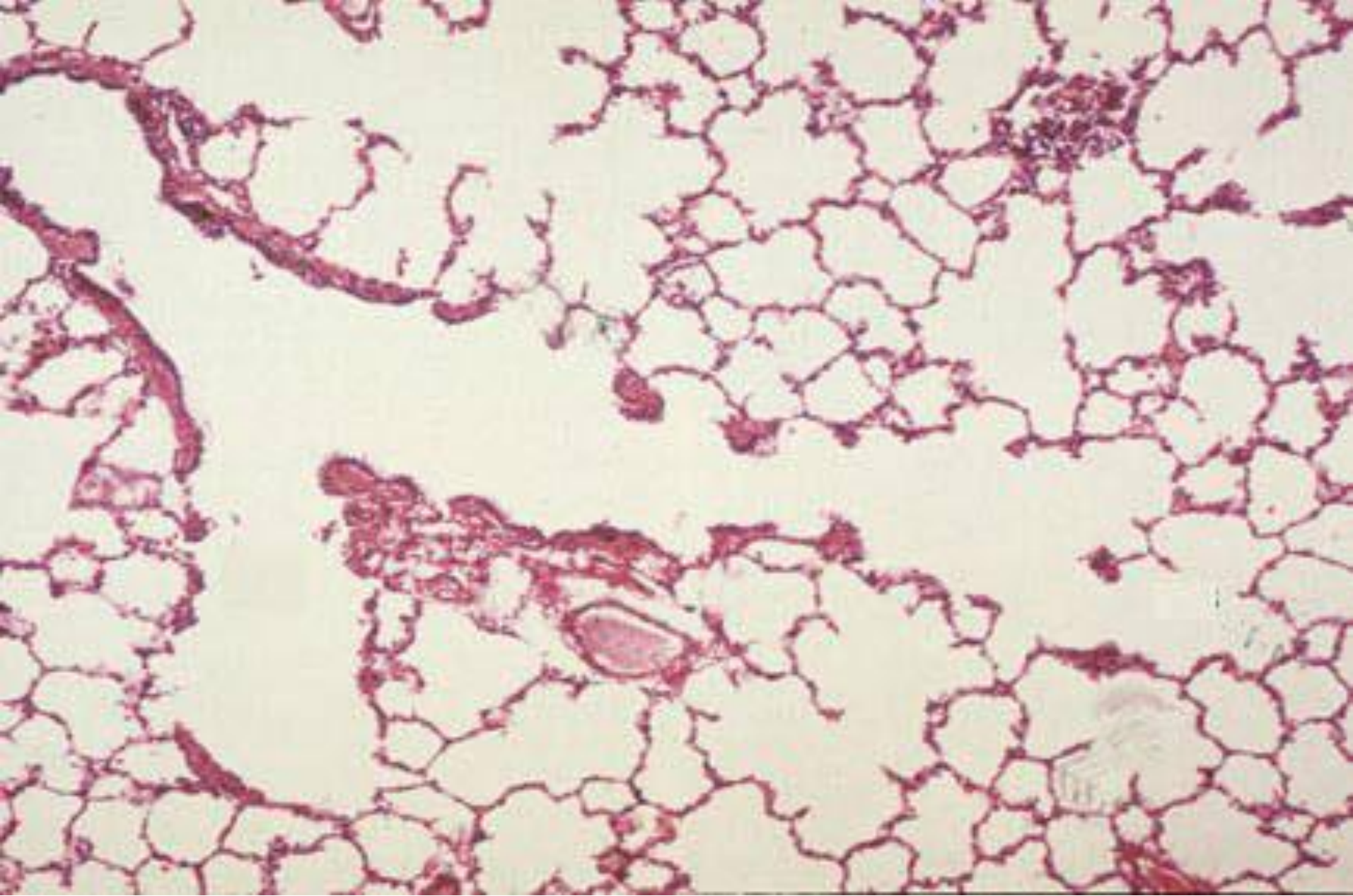


Bronchopneumonia: note the diffuse, patchy appearance.

Pathology of lobar pneumonia

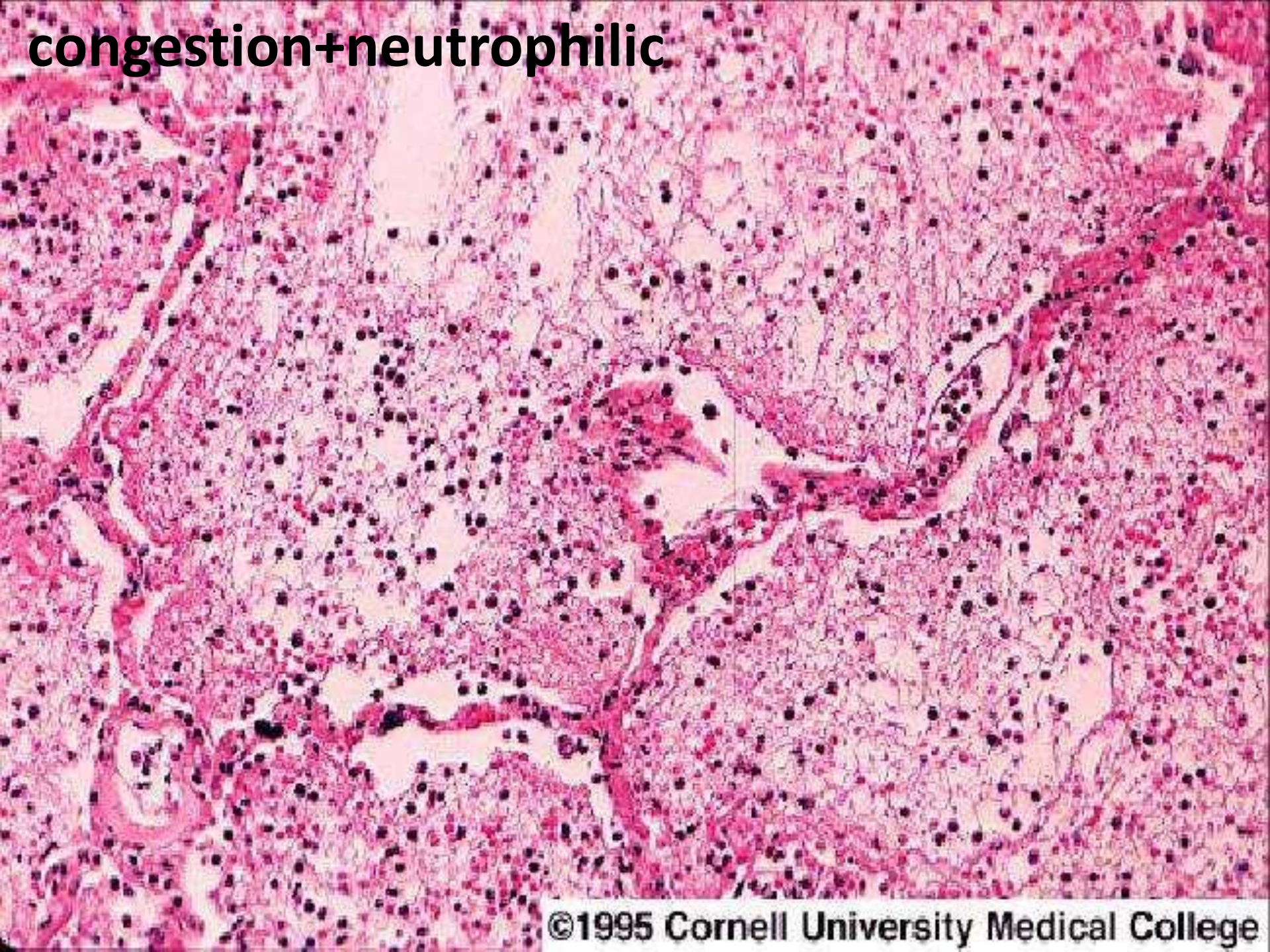
4 pathological phases:

- 1-Congestion:** 1-2 days. Pulmonary capillaries dilated and serous fluid leaks out capillaries into the alveoli. The patient is feverish with SOB and cough.
- 2-Red hepatization:** 2-4 days. That is means the lung look like 'red liver'. The affected lobe is solid as the alveoli are full RBCs, neutrophils and fibrinous exudate instead of air, there is no gas exchange in this lobe. The patient becomes breathless and hypoxic. The cough is blood stained or rusty sputum.
- 3-Grey hepatization:** 4-8 days. The affected part look like 'grey liver'. The alveoli are full of neutrophils and dense fibrous strands. The patient cough up of purulent sputum and remain breathless.
- 4-Resolution:** Begins after 8-10 days (without antibiotics). Monocytes clear the inflammatory debris and normal air filled lung architecture is restored. Improvement of patient's condition.



Microscopic section of normal lung showing terminal bronchiole, respiratory bronchiole, alveolar duct, alveolar sac, and alveoli.

congestion+neutrophilic

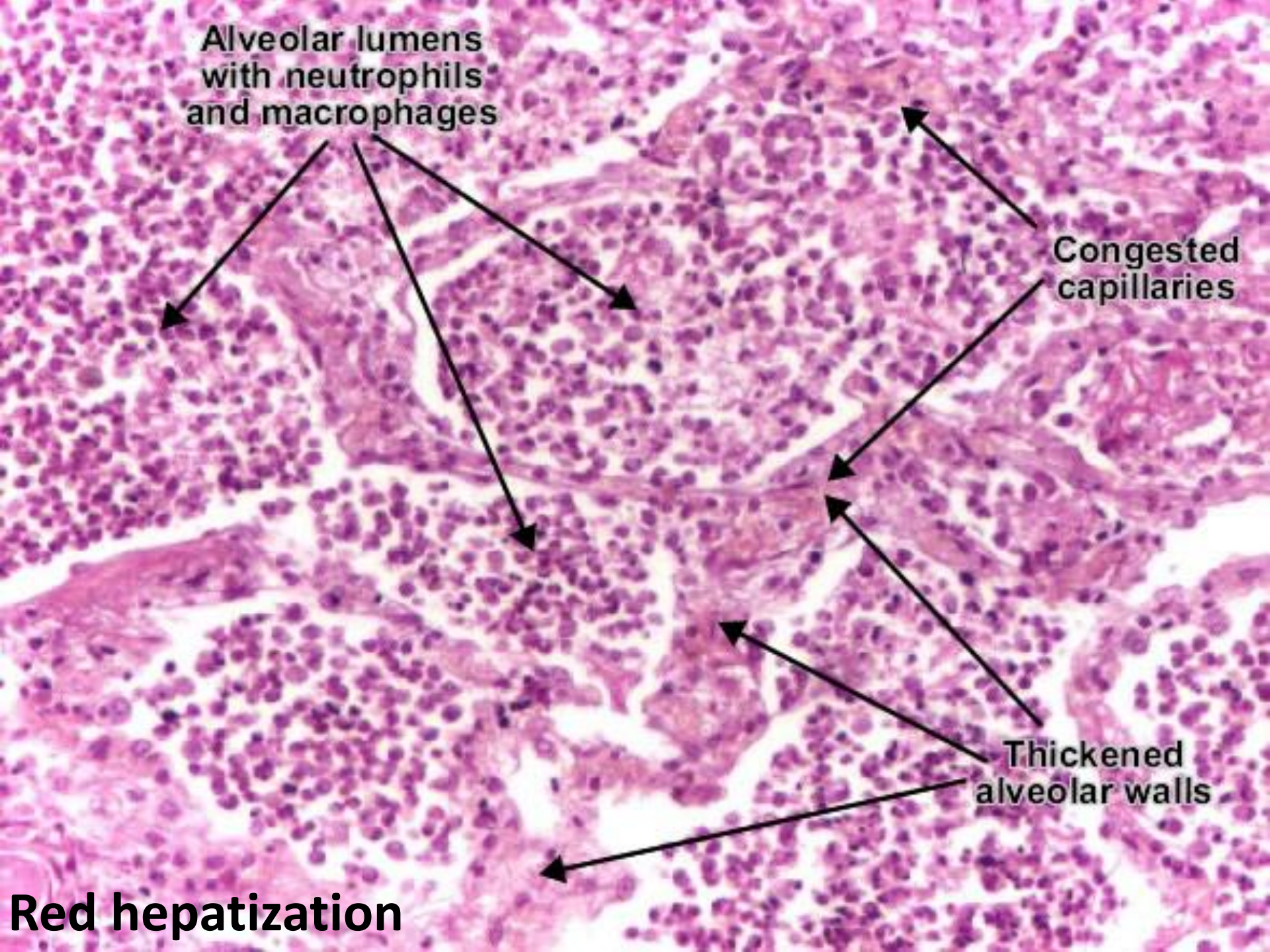


**Alveolar lumens
with neutrophils
and macrophages**

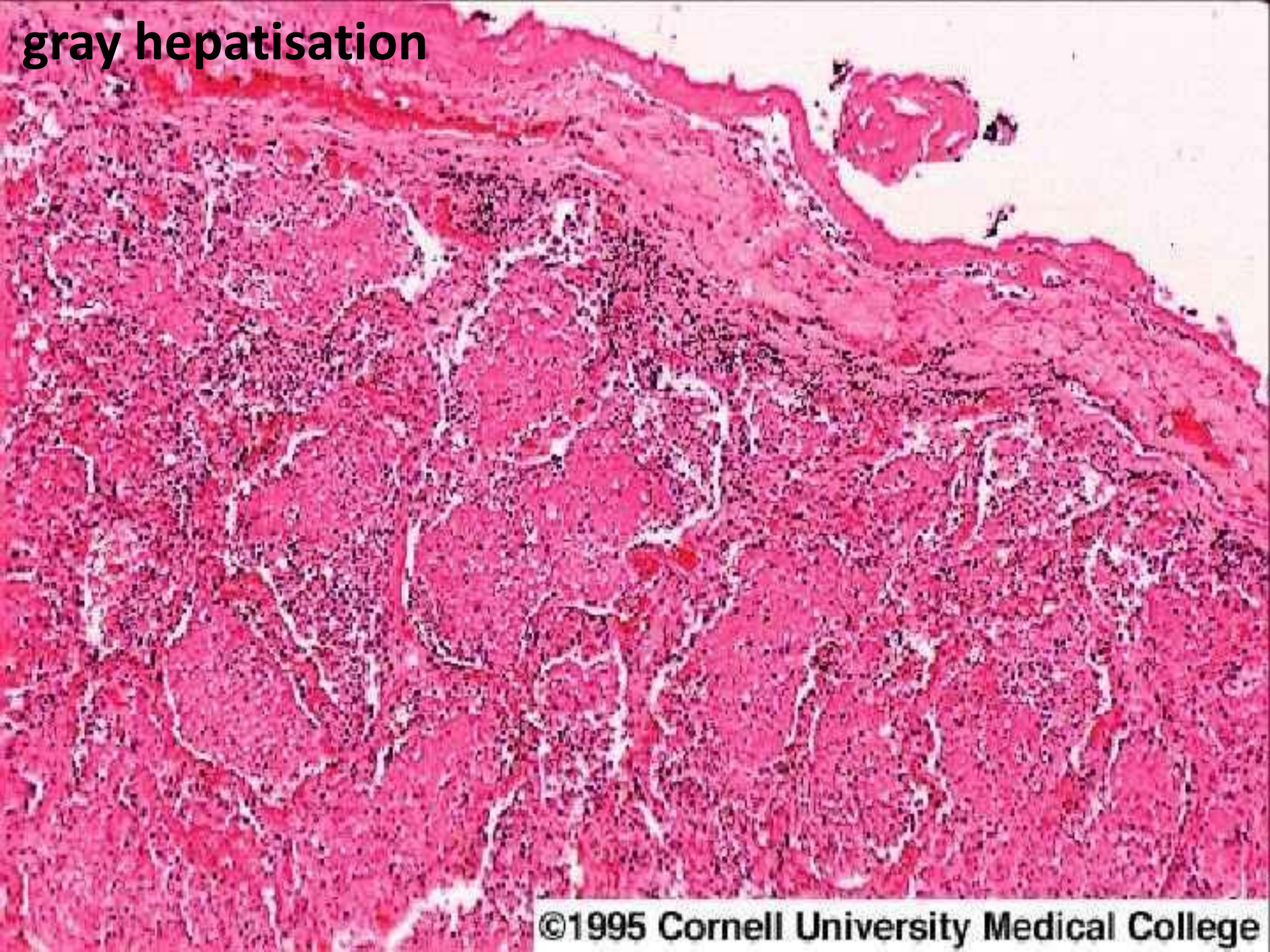
**Congested
capillaries**

**Thickened
alveolar walls**

Red hepatization



gray hepatisation



COMMUNITY-ACQUIRED PNEUMONIA (CAP)

- CAP: is pneumonia in patients living independently in the community.
- The incidence varies with age, being much higher in the very young and the elderly
- Most patients may be safely managed at home, but hospital admission is necessary in 20-40% of patients (5-10% of whom require intensive care)
- CAP is usually spread by droplet infection and most cases occur in previously healthy individuals.

Factors that predispose to pneumonia

1. Cigarette smoking
2. Upper respiratory tract infections
3. Alcohol
4. Corticosteroid therapy
5. Old age
6. Recent influenza infection
7. Pre-existing lung disease
8. HIV
9. Indoor air pollution

Organisms causing community-acquired pneumonia

Bacteria

- *Streptococcus pneumoniae*
- *Mycoplasma pneumoniae*
- *Legionella pneumophila*
- *Chlamydia pneumoniae*
- *Haemophilus influenzae*
- *Staphylococcus aureus*
- *Klebsiella pneumoniae*
- *Actinomyces israelii*

Viruses

- Influenza, parainfluenza
- Measles
- Herpes simplex
- Varicella
- Adenovirus
- Cytomegalovirus (CMV)
- Coronavirus (SARS-associated coronavirus)

Microorganisms & clinical features of CAP

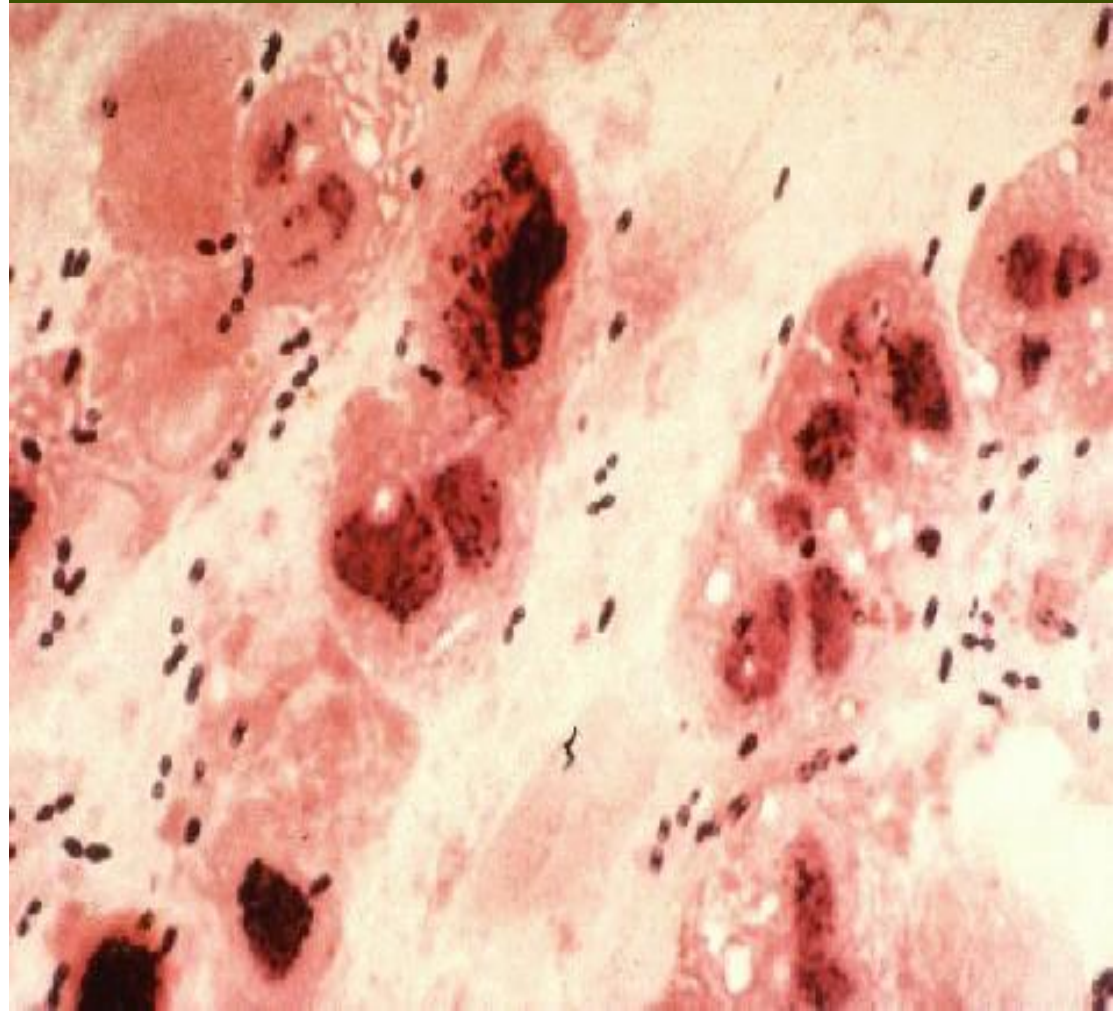
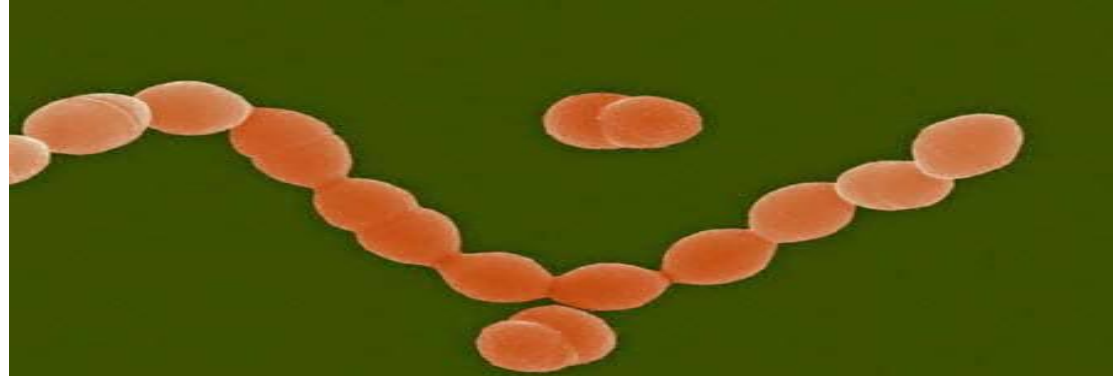
Common organisms

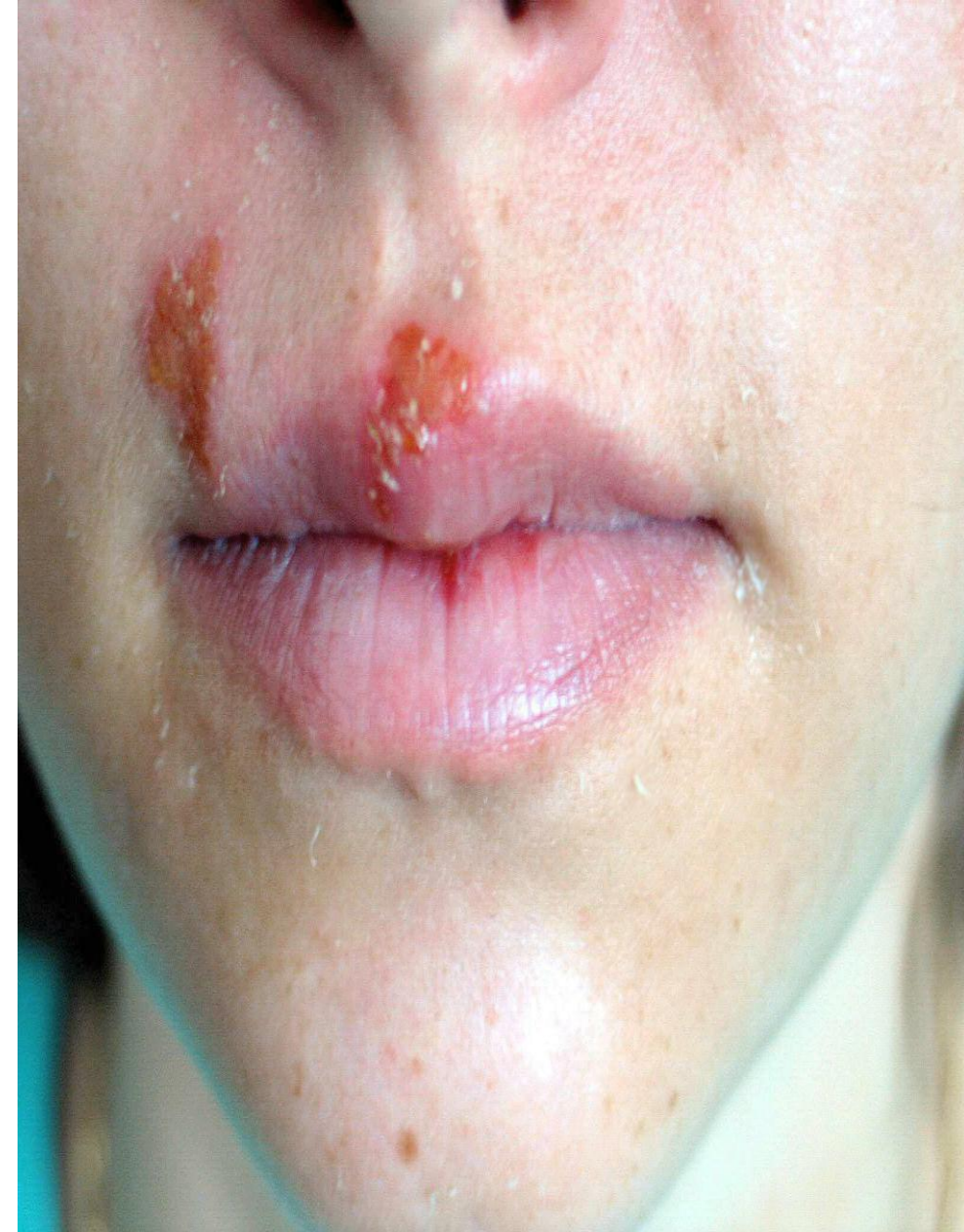
1- *Streptococcus pneumoniae*: The most common cause of classic or typical pneumonia.

Most common in winter. All age groups but particularly young to middle-aged.

- Rapid onset of systemic features such as fever, rigors, shivering, herpes labialis, tachycardia and malaise predominate and delirium may be present.
- Pulmonary symptoms include tachypnea, cough, which at first is painful and dry, but later accompanied by the mucopurulent or rust-coloured sputum, or occasionally hemoptysis.
- Pleuritic chest pain may be a presenting feature.

• *Streptococcus pneumoniae* are gram-positive cocci that occur in chains or pairs.





Herpes labialis and rusty sputum



2- Mycoplasma pneumoniae:

Most common in children and young adults. Common in autumn. Epidemics occur every 3-4 years.

After (2–3 weeks) incubation period, fever and constitutional symptoms develop along with headache and cough, but pleuritic pain is uncommon.

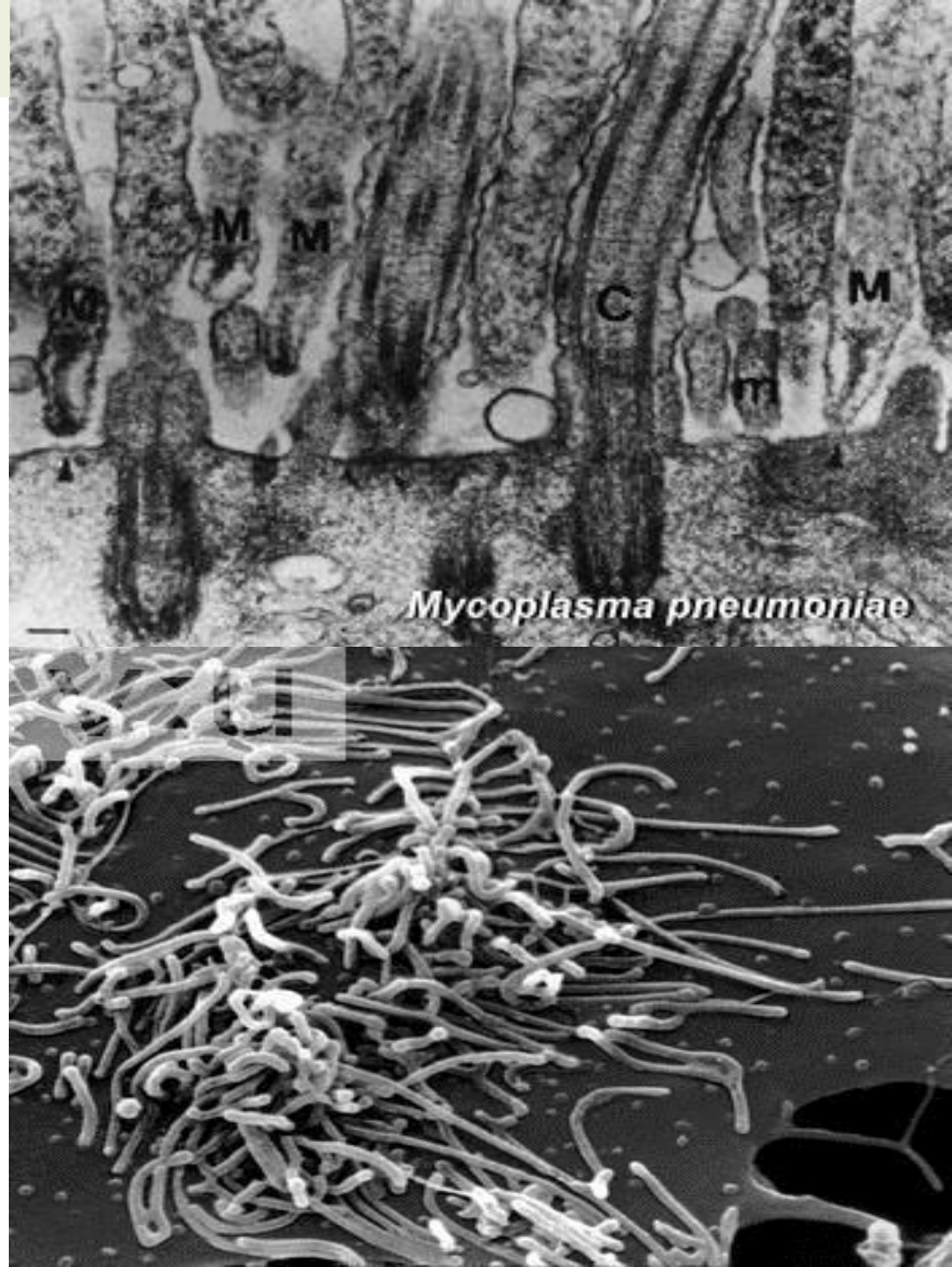
Rare complications include haemolytic anaemia, Stevens-Johnson syndrome, erythema nodosum, myocarditis, pericarditis, meningoencephalitis, Guillain-Barré syndrome.

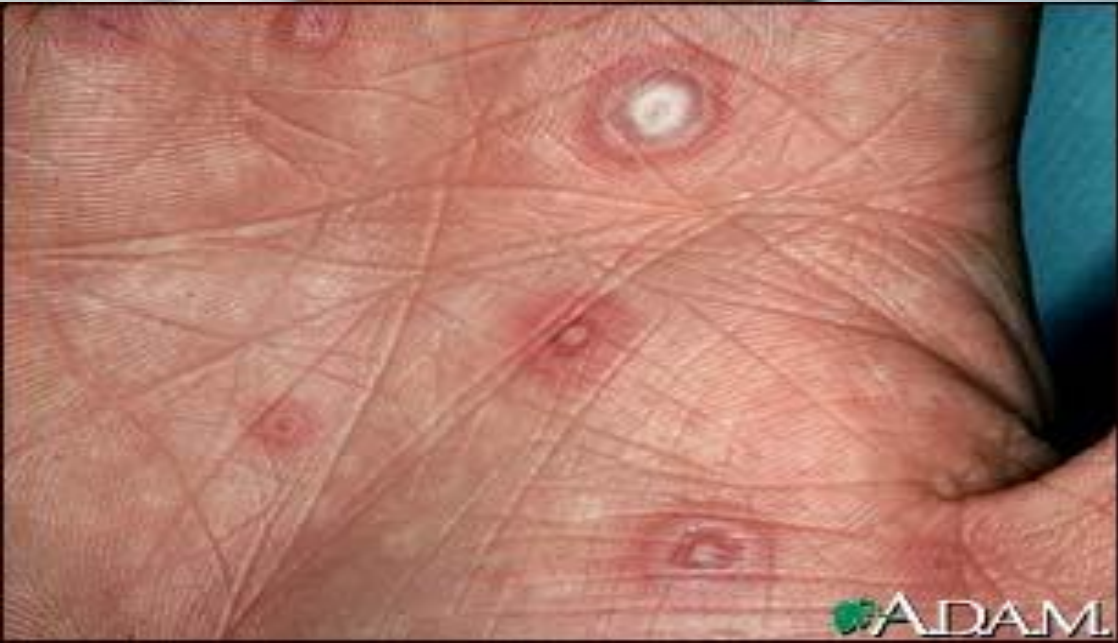
Grown on artificial media takes upwards of 2 weeks.

Mycoplasma pneumoniae

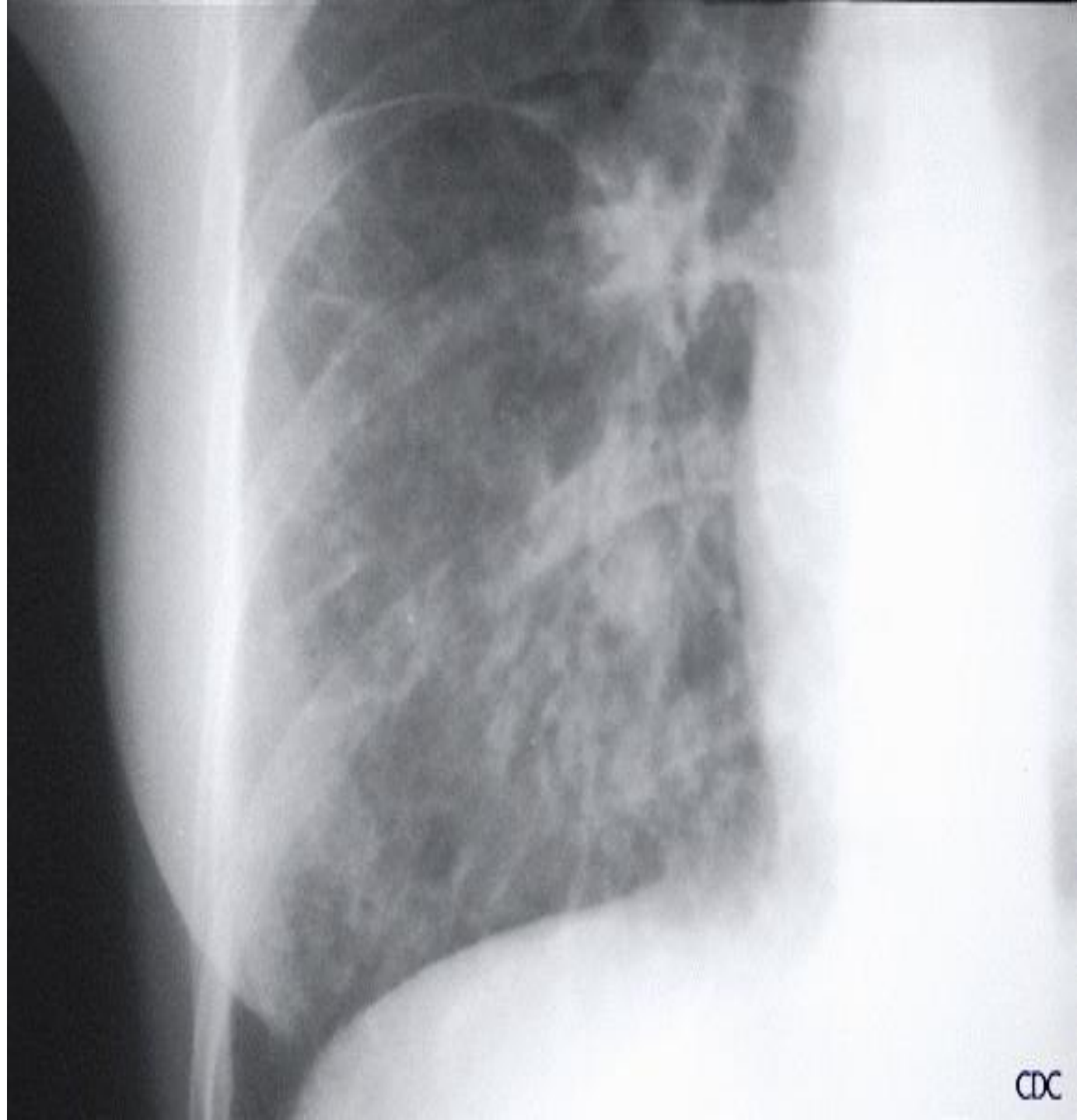
Mycoplasmal pneumoniae is one of the smallest organisms 125-150 μm . Is a pleomorphic organism that, unlike bacteria, lacks a cell wall, and unlike viruses do not need a host cell for replication.

Infection is spread from person to person by respiratory secretions expelled during bouts of coughing, causing epidemic or sporadic occurrence.





**Chest
radiograph may
show
reticulonodular
or interstitial
infiltration,
primarily in the
lower lobes.**



3- *Chlamydia pneumoniae*:

Young to middle-aged, large-scale epidemics, or sporadic, often mild, self-limiting disease. Headaches and a longer duration of symptoms before hospital admission.

The pneumonia resembles that of *Mycoplasma pneumonia* in that patients often have prominent antecedent upper respiratory tract symptoms, fever, nonproductive cough, mild to moderate illness, minimal findings on chest auscultation, and small segmental infiltrates on chest x-ray.

Usually diagnosed on serology.

4- *Legionella pneumophila*:

Middle to old age, recent foreign travel, local outbreaks centered on contaminated cooling towers in hotels, hospitals and other industrial buildings. A variety of features are said to be more common such as nonproductive cough, headache, confusion, malaise, myalgia, high fever and diarrhoea.

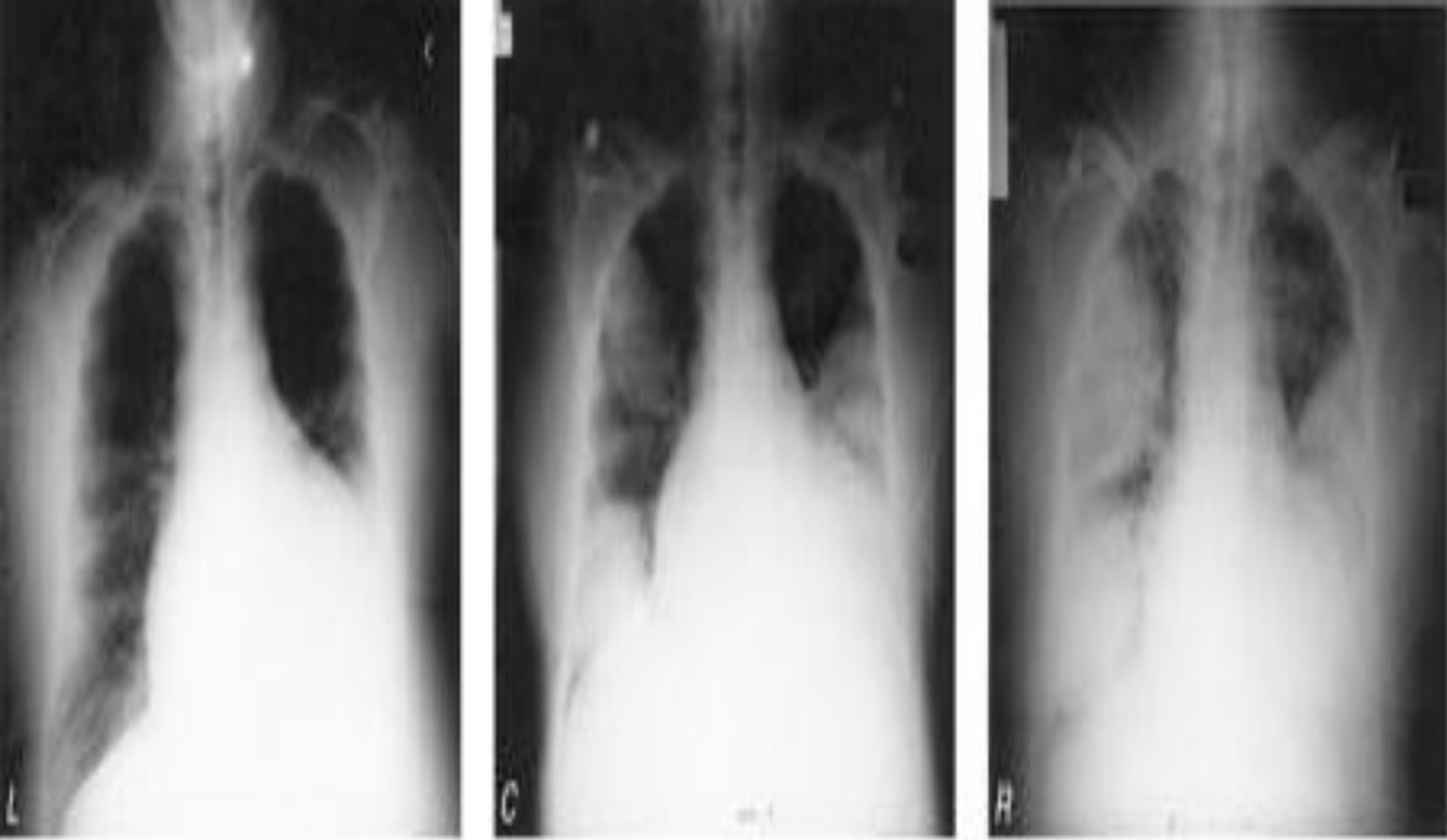
Laboratory results include hyponatraemia, elevated liver enzymes, hypoalbuminaemia and elevated creatine kinase. Chest X-ray appearances may be slow to resolve.

Legionella pneumophila:

are small, gram-negative, aerobic bacilli.

Legionnaires' disease is acquired by inhaling aerosolized water containing *Legionella* organisms or possibly by pulmonary aspiration of contaminated water. from humidifiers, shower heads.





Legionnaires' disease: No diagnostic features on the chest X-ray distinguish it from other pneumonia. But may showing pulmonary infiltrates: Infiltrates can be unilateral, bilateral, patchy, or dense, and in severe illness it may be multilobar involvement, can spread very quickly to involve the entire lung.

Uncommon organisms:

1- *Haemophilus influenzae*:

H. influenzae, an exclusively human pathogen, is spread by airborne droplets, its gram-negative coccobacillus.

Clinically indistinguishable from other types of bacterial pneumonia (e.g. *Streptococcus pneumoniae*)

Often underlying lung disease (COPD, bronchiectasis)

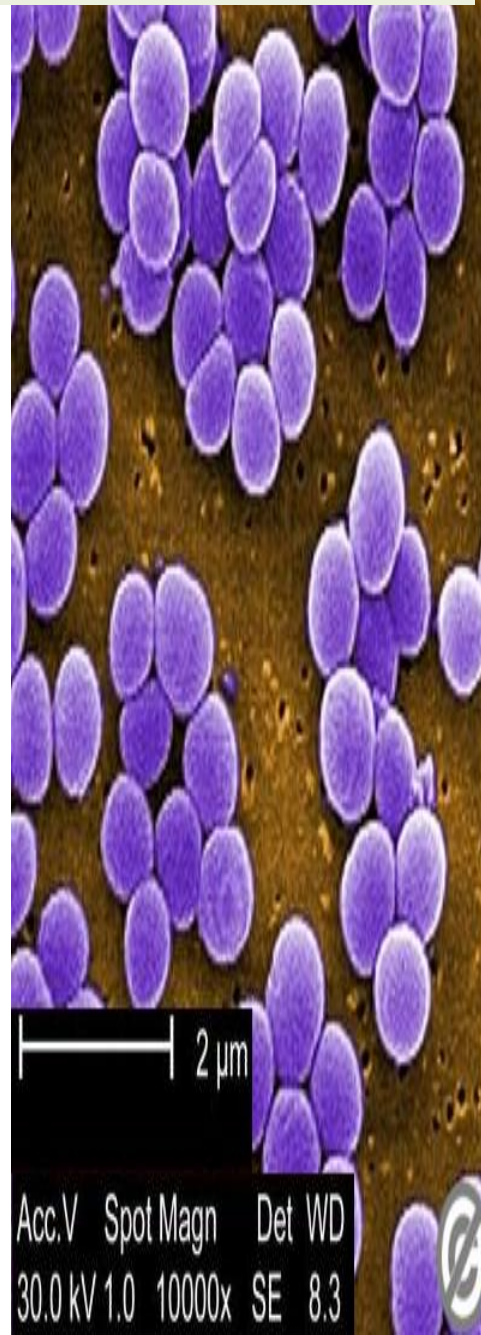
2- *Staphylococcus aureus*:

Coexistent debilitating illness and often preceded by influenza. Radiographic features include multilobar shadowing, cavitation, pneumatoceles and abscesses. Dissemination to other organs may cause osteomyelitis, endocarditis or brain abscesses. Mortality up to 30%.

Staphylococcus pneumonia

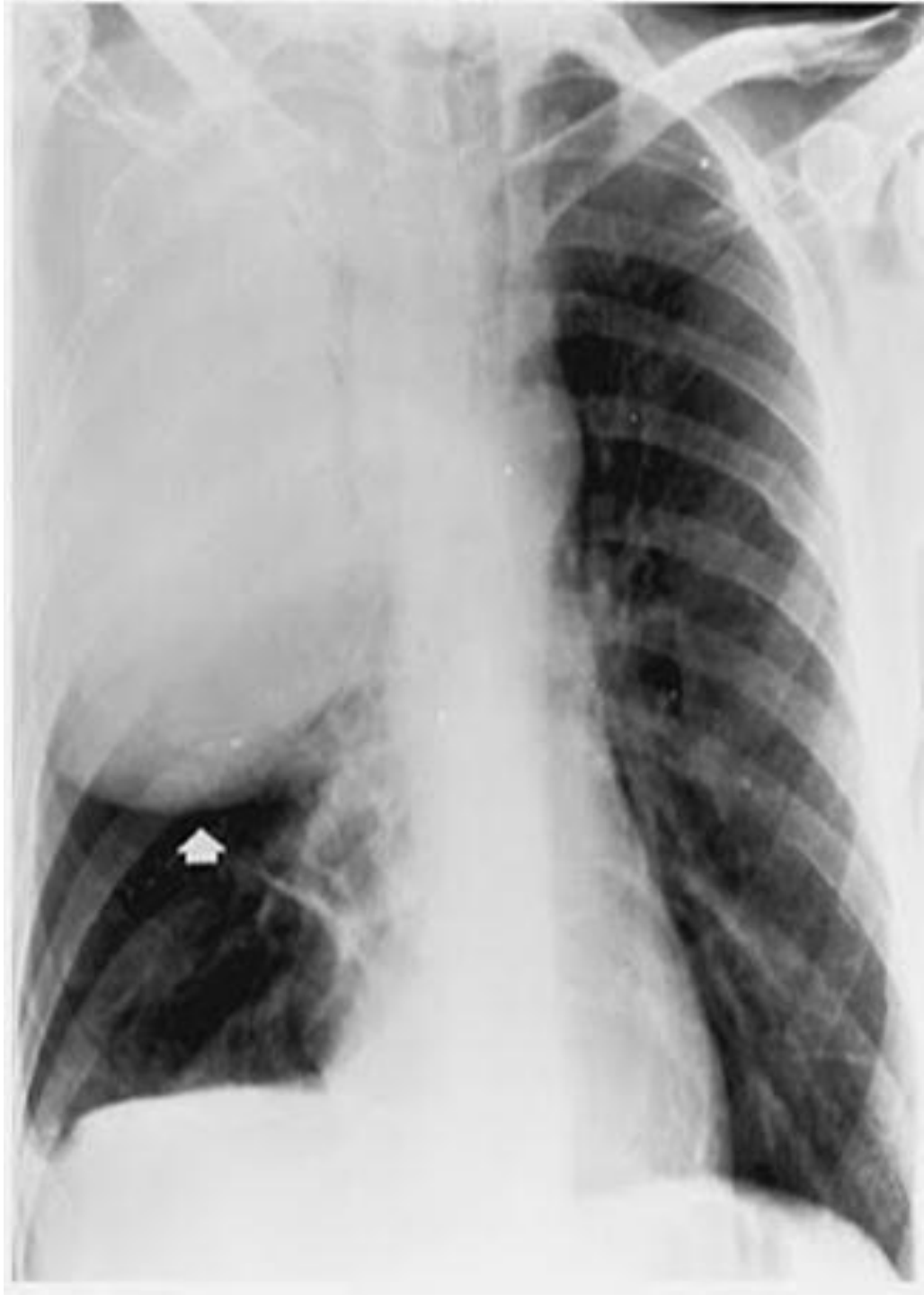
Staphylococci are gram-positive cocci, nonmotile, aerobic form grapelike clusters.

Chest X-ray show multiple lung abscess



3- *Klebsiella pneumoniae*: More common in aged men, malnourished and alcoholics. Upper lobe involvement typical. Low platelet count and leucopenia.

Klebsiella pneumoniae: a gram-negative bacilli



Atypical pneumonia: is an old term used to describe pneumonias where symptoms were more systemic (headache, malaise, joints pain, diarrhea) than pulmonary (cough, sputum, SOB). Atypical pneumonia was most often caused by pathogens such as *Mycoplasma*, *Chlamydia*, *Legionella*. as well as viral pneumonia.

Currently, it is recognized that symptoms do not reliably predict the infecting organism and that bacteria in atypical group commonly cause pneumonia.

Investigations

The main objectives of investigations

- to obtain radiological confirmation of the diagnosis
- to exclude other conditions that may mimic pneumonia
- to obtain a microbiological diagnosis
- to assess the severity of pneumonia
- to identify the development of complications.

Note: many cases of mild to moderate CAP can be successfully managed without identification of the organism

Blood tests

Full blood count

- Very high ($> 20 \times 10^9/L$) or low ($< 4 \times 10^9/L$) white cell count: marker of severity
- Neutrophil leucocytosis suggests bacterial aetiology
- Haemolytic anaemia: occasional complication of Mycoplasma

Urea and electrolytes

- Urea > 7 mmol/L (~ 20 mg/dL): marker of severity
- Hyponatraemia: marker of severity

Erythrocyte sedimentation rate/C-reactive protein: Non-specifically elevated

Liver function tests

- Abnormal if basal pneumonia inflames liver
- Hypoalbuminaemia: marker of severity

Blood culture: Bacteraemia: marker of severity

Serology: Acute and convalescent titres for Mycoplasma, Chlamydia, Legionella and viral infections

Cold agglutinins: Positive in 50% of patients with Mycoplasma

Arterial blood gases

- Measure when $SaO_2 < 93\%$ or when severe clinical features to assess ventilatory failure or acidosis

Sputum

- **Sputum samples** for Gram stain, culture and antimicrobial sensitivity testing
- **Oropharynx swab:** PCR for *Mycoplasma pneumoniae* and other atypical pathogens

Urine: Pneumococcal and/or *Legionella* antigen

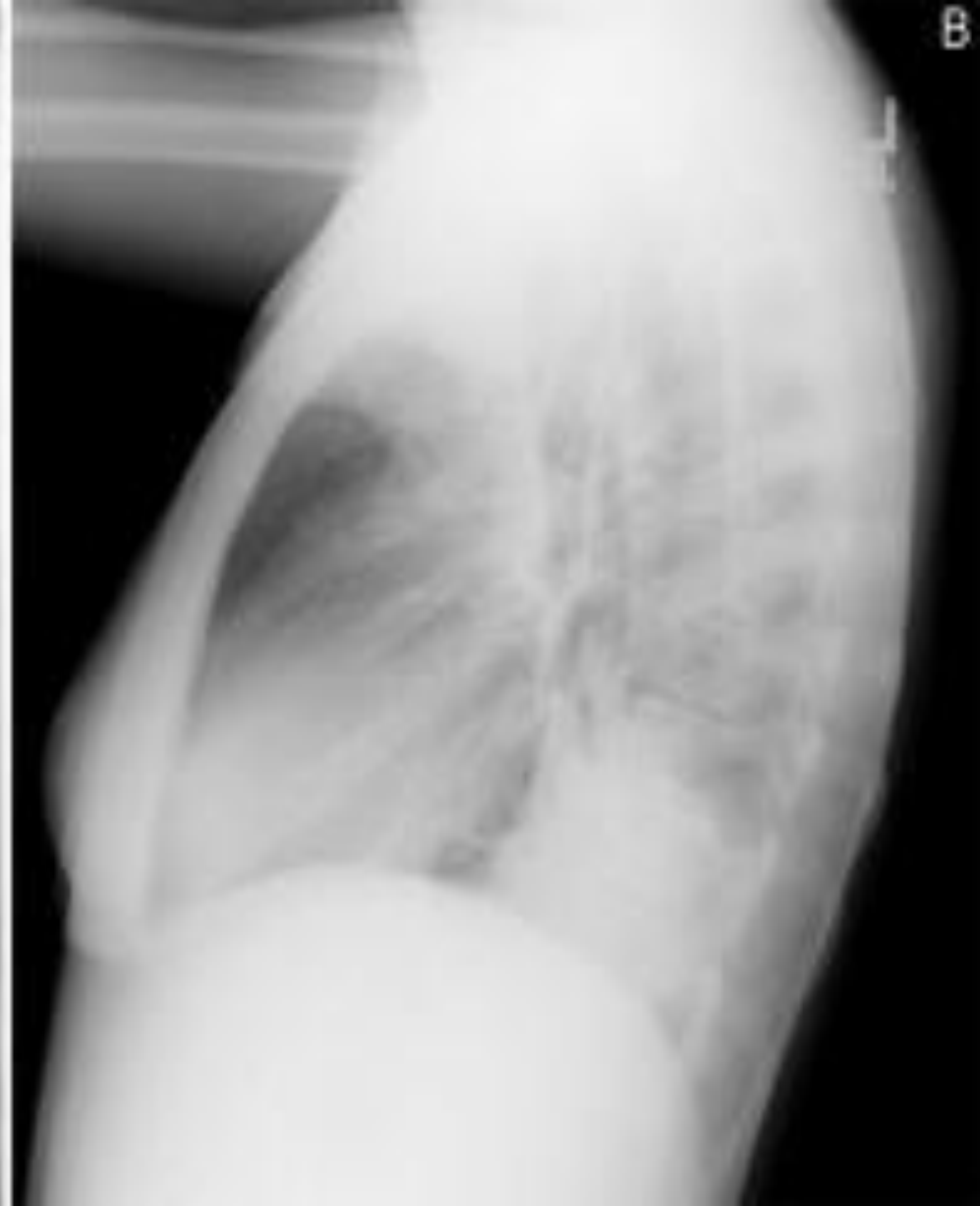
Chest X-ray

- **Lobar pneumonia:** homogeneous consolidation of affected lobe. Air bronchogram (air-filled bronchi appear lucent against consolidated lung tissue) may be present
- **Bronchopneumonia:** Typically patchy and segmental shadowing
- **Complications:** Para-pneumonic effusion, intrapulmonary abscess or empyema
- **Staph. Aureus:** Suggested by multilobar shadowing, cavitation, pneumatocoeles and abscesses

Pleural fluid: Always aspirate and culture when present

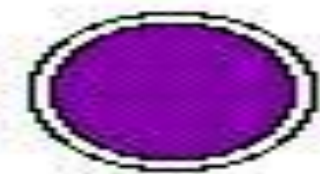
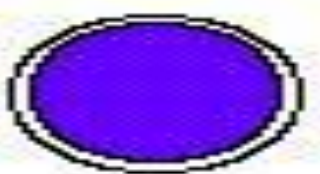


Lobar pneumonia



PA chest x-ray shows consolidation in the left lung base. A lateral view was obtained and shows that the consolidation is located posteriorly. Lateral view are especially important in showing infiltrates, which may be obscured by the heart on PA view.

GRAM +



Fixation



Crystal
Violet



Iodine
treatment



Decolorization



Counter stain
(safranin)

GRAM -

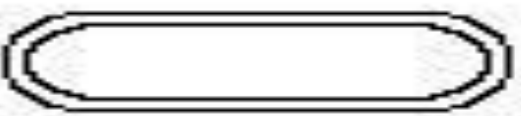
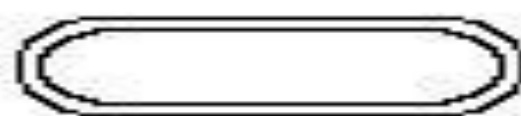
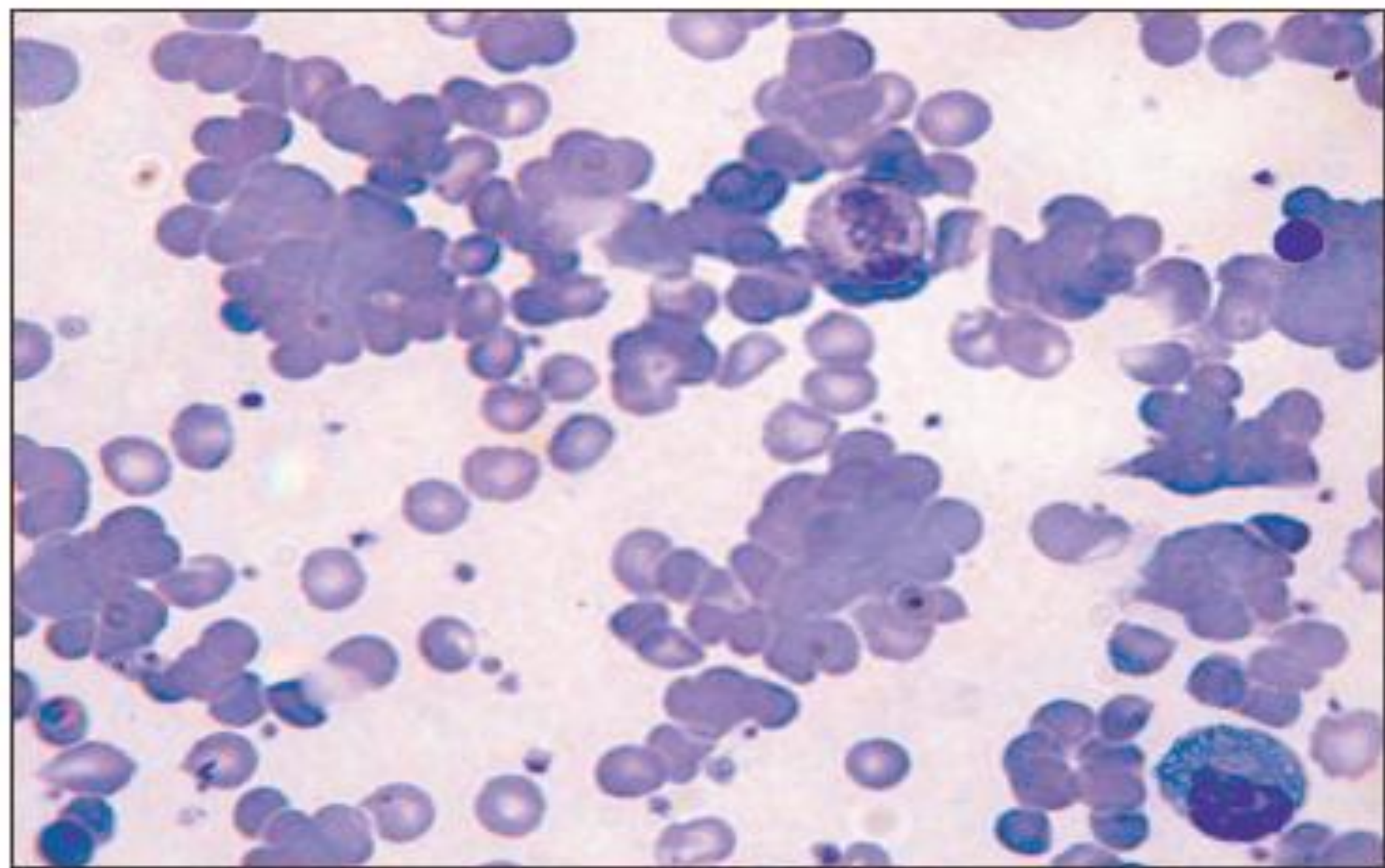
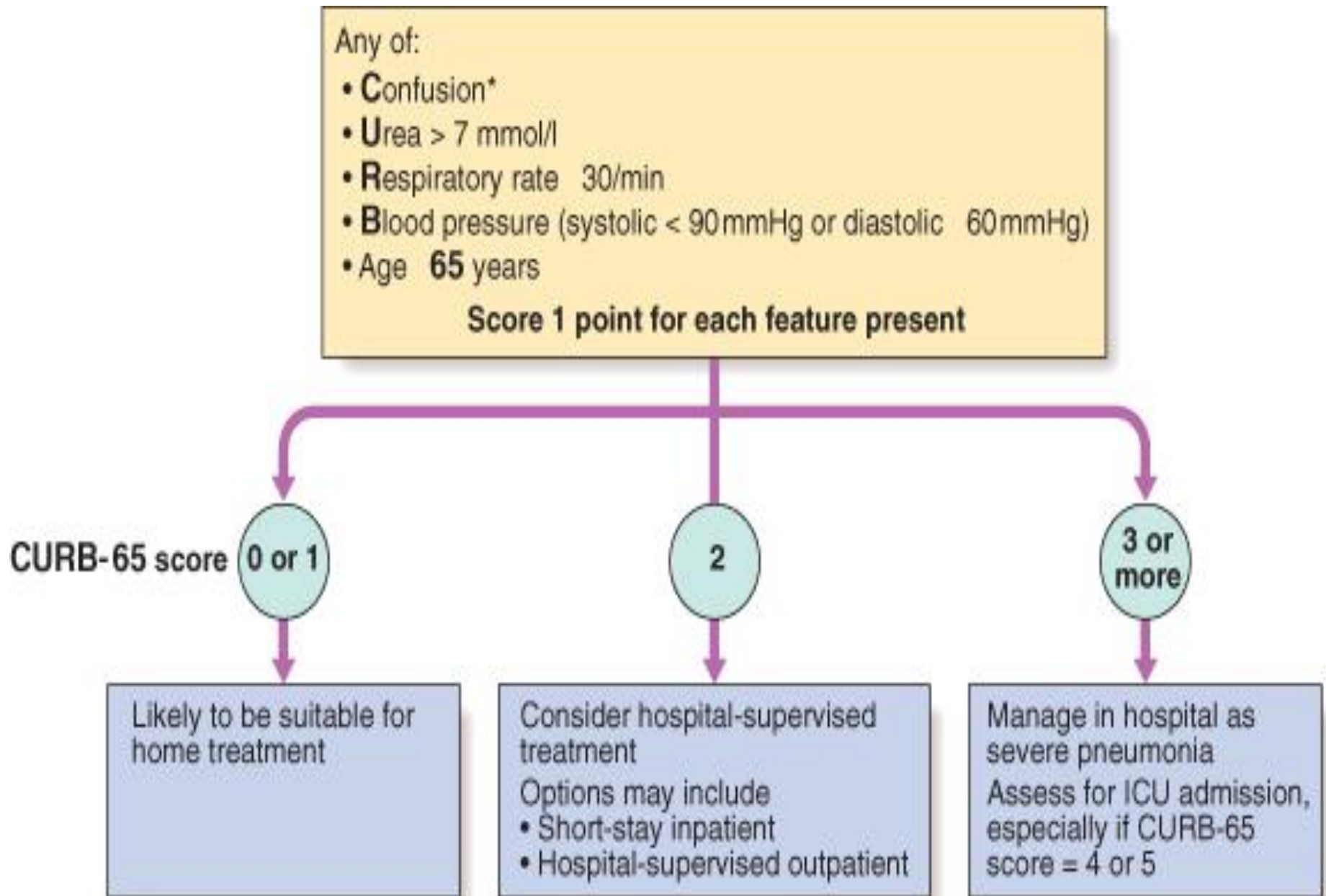


Figure 1. Peripheral blood smear showing red cell agglutination. (Wright stain x 1,000)



Assessment of disease severity



Management

- **Rest and avoid smoking.**
- **Oxygen:**

should be administered to all patients with tachypnoea, hypoxaemia, hypotension or acidosis. High concentrations (> 35%), preferably humidified.

- **Fluid balance:**

Intravenous fluids should be considered in those with severe illness, elderly patients and those whose systemic features include vomiting.

- **Antibiotic treatment:**

The choice of antibiotic is guided by clinical context, severity assessment, local knowledge of antibiotic resistance patterns, and at times epidemiological information.

Uncomplicated CAP: 7-10-day course is adequate.

- Amoxicillin 500 mg 8-hourly orally
- *If patient is allergic to penicillin*
 - Clarithromycin 500 mg 12-hourly orally or
 - Erythromycin 500 mg 6-hourly orally
- *If Staphylococcus is cultured or suspected*
 - Flucloxacillin 1-2 g 6-hourly i.v. *plus*
 - Clarithromycin 500 mg 12-hourly i.v.
- *If Mycoplasma or Legionella is suspected*
 - Clarithromycin 500 mg 12-hourly orally or i.v. or
 - Erythromycin 500 mg 6-hourly orally or i.v. *plus*
 - Rifampicin 600 mg 12-hourly i.v. in severe cases

Severe CAP: for 10–14 days

- Clarithromycin 500 mg 12-hourly i.v. *or*
- Erythromycin 500 mg 6-hourly i.v. *plus*
Co-amoxiclav 1.2 g 8-hourly i.v. *or*
- Ceftriaxone 1-2 g daily i.v. *or*
- Cefuroxime 1.5 g 8-hourly i.v. *or*
- Amoxicillin 1 g 6-hourly i.v. *plus* flucloxacillin 2 g 6-hourly i.v.

Treatment of pleural pain:

Relieve pleural pain in order to allow the patient to breathe normally and cough efficiently. Mild analgesics such as paracetamol are rarely adequate; however, opiates must be used with extreme caution in patients with poor respiratory function.

Complications

- Para-pneumonic effusion-common
- Empyema
- Retention of sputum causing lobar collapse
- Development of thromboembolic disease
- Pneumothorax-particularly with *Staph. aureus*
- Suppurative pneumonia/lung abscess
- ARDS, renal failure, multi-organ failure
- Ectopic abscess formation (*Staph. aureus*)
- Hepatitis, pericarditis, myocarditis, meningoencephalitis
- Pyrexia due to drug hypersensitivity

Discharge and follow-up

- Discharge clinically stable with clinical review after 6 weeks
- No discharge in the presence of more than one of the following clinical signs: temperature $> 37.8^{\circ}\text{C}$, heart rate $> 100/\text{min}$, respiratory rate $> 24/\text{min}$, systolic BP < 90 mmHg, $\text{SaO}_2 < 90\%$, inability to maintain oral intake and abnormal mental status. New CXR should be obtained.

HOSPITAL-ACQUIRED PNEUMONIA (HAP)

HAP or nosocomial pneumonia refers to a new episode of pneumonia occurring at least 2 days after admission to hospital.

- Usually in elderly patients, patients in intensive care units, (especially when mechanically ventilated) and post-operative patients.
- The factors predisposing to HAP are: Reduced host defences against bacteria. Aspiration of nasopharyngeal or gastric secretions. Bacteraemia.
- **Aetiology:** the common pathogens are:
 1. Gram-negative bacteria, includes Escherichia, Pseudomonas and Klebsiella species.
 2. Staph. aureus (including multidrug-resistant-MRSA-forms)
 3. Anaerobic organisms.

Clinical features and investigations:

the diagnosis of HAP should be considered in any hospitalized or ventilated patient who develops:

- Purulent sputum
- New radiological infiltrates
- Unexplained increase in oxygen requirement
- Body temperature of more than 38.3°C
- Leucocytosis or leucopenia.

The clinical features and radiographic signs are variable and non-specific, therefore, in contrast to CAP, microbiological confirmation should be sought whenever possible.

Chest X-ray shows mottled opacities in both lung fields, chiefly in the lower zones (Bronchopneumonia).



Management of HAP

- A third-generation cephalosporin (e.g. cefotaxime) plus an aminoglycoside (e.g. gentamicin) to cover Gram-negative bacteria, including *Pseudomonas*.
- Antipseudomonal agents e.g. carbapenem (meropenem)
- A monocyclic β -lactam (e.g. aztreonam) plus flucloxacillin to cover *Staph. aureus*.
- Vancomycin to cover MRSA
- Metronidazole to cover anaerobic organisms.
- Physiotherapy ,adequate oxygen therapy, fluid support and monitoring are essential.
- The mortality from hospital-acquired pneumonia is high (approximately 30%).

Aspiration pneumonia

It develop after the inhalation of septic material during operations on the nose, mouth or throat, under general anaesthesia, or of vomitus during anaesthesia or coma, particularly if oral hygiene is poor. Additional risk factors for aspiration pneumonia include bulbar or vocal cord palsy, achalasia or oesophageal reflux, and alcoholism. Aspiration tends to localize to dependent areas of the lung, such as the apical segment of the lower lobe in a supine patient.

Infections are usually due to a mixture of anaerobes and aerobes in common with the typical flora encountered in the mouth and upper respiratory tract.

Aspiration pneumonia can usually be treated with co-amoxiclav and metronidazole, for 4–6 weeks may be required in some patients with lung abscess.

Pneumonia in the immunocompromised patient

Patients immunocompromised by drugs or disease (particularly human immunodeficiency virus (HIV) infection) are at increased risk of pneumonia, which is the common cause of death in this group.

Patients with profound immunosuppression, infected by low virulence or non-pathogenic, 'opportunistic' pathogens, especially *P. aeruginosa*, viruses, fungi, *Pneumocystis jirovecii*, mycobacteria and *Nocardia* spp.

Clinical features: include fever, cough and breathlessness but are influenced by the degree of immunosuppression. In *P. jirovecii* pneumonia, symptoms of cough and breathlessness can be present several days or weeks before the onset of systemic symptoms or the appearance of radiographic abnormality.

- Patients are too ill to undergo invasive investigations (bronchoscopy, BAL, transbronchial biopsy or surgical lung biopsy) however, 'induced sputum' offers a relatively safe method of obtaining microbiological samples.
- HRCT can be helpful: focal unilateral airspace opacification favours bacterial infection or mycobacteria. bilateral opacification favours *P. jirovecii pneumonia*. cavitation may be seen with *mycobacteria* and fungi, the presence of a 'halo sign' (a zone of intermediate attenuation between the nodule and the lung parenchyma) may suggest aspergillosis.
- Therapy should be commenced immediately, e.g. a third-generation cephalosporin, or a quinolone, plus an antistaphylococcal antibiotic, or an antipseudomonal penicillin plus an aminoglycoside.

Thanks